

# ON THE USEFULNESS OF THE PARTS

[II, 336]

ing altogether or very small indeed? Is it not primarily because the female testis itself is small and the spermatic vessel [the Fallopian tube] is small too, so that it is not at all surprising that the part joining them should also be small? Then, too, the difference between their substances is a slight one, and not very great as it is in the male. Moreover, the male testes are softer and more moist than those of the female and the male spermatic vessels are harder. In the female the opposite is true, the spermatic vessels being less hard for the reasons I have given and the testes less loose-textured, porous, and moist, because their substance is colder; for they have not been inflated and leavened, so to speak, by the innate heat. With good reason, then, the substances [of the two parts] are nearly alike [in the female], since the testes have been made harder and the spermatic vessels inserted into them are softer, and hence there was no necessity for the parts to be joined together by a large body which would gradually recede from the hardness of one of them and approach the softness of the other.

Since the male testes are suspended, a muscle [*cremaster*] comes down to each of them from the region of the flanks, in order that these too may have their share of voluntary motion. I have demonstrated in my commentaries *On the Semen* what the semen from the female contributes to that of the male, what the nature of each is, and all such subjects, and I should now bring this book to a close at this point; in the next I shall point out all the skill of Nature as displayed in her treatment of the fetus.

# THE FIFTEENTH BOOK OF GALEN ON THE USEFULNESS OF THE PARTS

[II, 337]

## [The Reproductive Tract, the Fetus, and the Hip Joint]

1. Although to preserve the race Nature has devised the many wonderful instruments which have been described in the preceding book, I feel sure that when you see in dissections the construction of the pudendum, the wisdom displayed in its creation will seem no less wonderful to you than that displayed in creating the others. Now in the first place (and this is a common fact and well known to all), since it was better, as I have shown earlier, to make two animals to generate, Nature constructed for one of them parts suited to receive the semen and for the other, parts suited to emit it; secondly, she endowed them with faculties that would make good use of the instruments; and thirdly, there is the fact that all parts of the instruments, even the smallest, have the best position, size, contexture, and form, in short, all the qualities which I have said times without number are proper to bodies. In fact, you cannot find a single part in them that is superfluous or deficient, that ought to be transposed or differently formed, or that lacks density if density is suitable for it, or looseness of texture when this is what it needs, or a channel if its task is to expel, or a cavity if it must receive. No, you will find them all arranged to the height of perfection, each with reference to its own usefulness.

For example, you could not conceive of any better place to locate the two pudenda, either in the whole body or within the region they now occupy, even if you moved them only a little in any direction, forward, back, up, or down. In the preceding book I have explained sufficiently why they needed to be placed in the particular region

[II, 338]

where they actually are, but now give me your attention while I explain that within this region itself they could not be rearranged even very slightly and be the better for it. Where else, indeed, would you be willing to place the pudendum of the male (for I shall begin with this)? Would you put it nearer the anus than it is now? But [then] it would overhang the anus itself and make it difficult to expel excrement, unless perhaps you think it better to have the penis always tense and protruding. If so, however, you would merely be postponing the difficulty; for although it would cause no trouble when excrement was expelled, the penis would become a source of annoyance in every other aspect of life and would be easily injured, just as the hand would if a man should carry it around stretched out in front of him. Perhaps, then, it was better to place the penis further up on the pubes or hypogastrium? But here again you must add whether it should be always tensed or always lax, or should be capable of tensing and relaxing by turns.

[II, 339]

Now if it were always tense, it would be easily injured and in addition would be a lifelong nuisance, being useful only at the time of coitus; if it were always relaxed, it would then be completely useless and never capable of doing what it was made to do; but if it is relaxed and tensed by turns, it is proper first to marvel because it has obviously now been made such as reason has found that it ought to be, and then to consider what construction would best enable it quickly to change into such antithetical conditions. If it were made like a vein, would it be filled and emptied easily, and would it besides be strongly tensed while it was filling? Well, the substance of blood does not take so kindly to such speedy filling and emptying as that of air, pneuma, or some such quick-moving material does, and, moreover, the tunic of a vein would not endure strong tension while being filled; for it is strong, sinewy substances that are useful for such actions. Perhaps, then, it would be better if the penis were made like an artery. But in addition to the drawbacks I have already mentioned in speaking of the veins, the arteries also pulsate at their own rate, and when they have been filled you could not bid them remain so, nor, when they were contracted, could you forbid them to expand again.

So was it better to make the penis like a nerve? Here, however, the difficulty is to tell from what sort of a nerve to make it. For the nerves properly so-called, those that grow out from the encephalon

and spinal medulla, not only have no perceptible cavities and do not naturally expand and contract but also in acting with tension have the disadvantage of being soft. What Hippocrates<sup>1</sup> calls ligaments and more modern physicians call connective nerves are not unsuited to acting with tension, since they are hard, but they too have no cavities. The nervous bodies that grow out from the muscles and are called tendons by Hippocrates<sup>2</sup> are altogether useless for constructing the penis, not only because like those already mentioned they have no cavities, but also because they are not so hard as the ligaments. Now if there are three kinds of nervous bodies in all, if those having the encephalon and spinal medulla as their source are found to resemble those [the tendons] growing out from the muscles in being unsuitable in two respects (for they are softer than the penis ought to be, and they have no cavities), and if those [the ligaments] produced from the bones are useful insofar as they are hard but useless because they are not hollow, there is no kind of nerve remaining that is fit to use in constructing the penis. I have shown that neither arteries nor veins are suitable, and it is clearly evident that neither flesh, glands, bone, cartilage, nor anything else of the sort is in any way suitable either.

[II, 340]

Ought we not, then, first to admire the wisdom and providence of the Creator? Indeed, though it is far easier to recount in words the generation of everything that has been made than actually to construct the works themselves, my discourse falls so far short of the wisdom of the One who has created us that I cannot even explain the things he has so easily made. Secondly, along with our admiration and lack of words to tell of the clever device used in constructing the pudenda, we must try dissection of the part and see if our Creator has not discovered some kind of substance that is suitable for the penis. Then, if we should find nothing that cannot also be observed in some other part, we must admire the way in which he has created from the same instruments actions that are not the same. If, on the other hand, we should find some bodily substance not to be observed in a single other part, we ought here again to praise the Creator for his foresight and ought never to leave alone what we

[II, 341]

<sup>1</sup> σύνδεσμοι; see, for example, *De arte*, cap. 10 (Littre, VI, 18, 19).

<sup>2</sup> For example, in *De fracturis*, cap. 11 (Littre, III, 452, 453). For the many other occurrences of both τένοντες and σύνδεσμοι in the Hippocratic corpus, consult Littre's index.

# ON THE USEFULNESS OF THE PARTS

have sought out before testing it thoroughly in dissection. Well, at some time or other you have already seen it<sup>3</sup> when some physician was demonstrating to those who care about the works of Nature. But if you have not, you should at least examine now the sinewy (nervous), hollow body [the corpus cavernosum of the penis] growing out devoid of moisture from the bones called pubic. For this is what we have just been seeking by means of reason without finding it, and what we should never have found if we had not been taught by dissection. In fact, we did not presume to imagine a thing which we had not seen in any other part of the entire body. If we were really natural philosophers, we would certainly understand that since the substance proper for pudenda must be both hard and hollow, it grows out from bone as all the other ligaments do, and that it is the only one of them all to be hollow, because its usefulness requires it to be so.

[II, 342]

These are the things, then, that our Creator wished to be made, and since they have been made, do not attempt or venture to find out how it was done. For how could you reasonably bring yourself to inquire how things were made, the existence of which you would not have discovered if you had not been taught by dissection? It is enough for you to have made as great a discovery as this, that every part has been constructed to be what its usefulness requires, and if you undertake to investigate how a part has been made such as it is, you will stand convicted of not realizing either your own weakness or the power of the Creator. But now that you have found out that the parts of the pudendum (whatever they should be called—nerves, or anything else you please) absolutely must grow out from bones, because the substance proper to them is such as I have told earlier and because it was better so in view of their actions, so that the whole pudendum by growing out from a firm substance may be kept straight and unbending, let us return to the subject from which my discourse has thus far been digressing.

2. At the beginning of my discussion of the position of the pudenda, I have showed that the part called the penis must be engendered from bones. If so, it might indeed be nearer the anus than it actually is, but this was not better, as I have shown earlier,

[II, 343]

<sup>3</sup> Reading *εἶδες οὖν ἤδη ποτὲ* with Helmreich for the *εἰ δ' οὖν εἶδες ποτὲ* of Kühn's text.

# FIFTEENTH BOOK

and it could not possibly be placed [higher up than]<sup>4</sup> the pubes; for there is no bone there. Hence it grows out from the pubic bones, from their upper parts especially, since it will thus be farthest from the anus and will be better situated for coitus. Why it does not grow out from their left or right sides<sup>5</sup> you will learn from what follows: I have said many times already even in this work that when a certain part is unpaired, it must have a central location; that on the other hand, if there is a pair of parts, [Nature] wishes them to be equidistant from the center, that if in rare instances they do not maintain this distance, one must seek the reason for the variation, as I have shown in speaking of the liver, and that if the same distance is maintained, it is superfluous to mention it.

Now since I have said enough about the position of the penis and the nature and origin of the hollow, spongy nerves [the corpus cavernosum] in it, let us explain<sup>6</sup> the rest of its construction, though I shall omit here what seems obvious to all. For example, some one might demonstrate that the penis must be single or that it must have arteries, veins, and a skin, discussions that no longer have anything to do with examining the usefulness of the parts but are derived from the problems of natural philosophy. Another such question is how it happens that the penis is tensed voluntarily and sometimes without the exercise of the will. For that it does happen when the hollow nerve is filled with pneuma is appropriate to the business now in hand; how it happens belongs to a work on natural philosophy. Keeping in mind this restriction, I must now add to my discourse what is lacking.

[II, 344]

3. It remains in the first place to discuss what I mentioned briefly<sup>7</sup> just now, the necessity for the penis to be perfectly tensed in coitus. It is useful for the penis to be perfectly tensed not solely for the sake of coitus, as one might perhaps think, but also for dilating and straightening the channel [of the penis] in order that the semen may

<sup>4</sup> Supplying *ἀνωτέρω ἢ*, obviously needed if this statement is to bear out that in the last chapter at the point where the digression on the substance of the penis began. Daremberg (in Galen [1856, II, 135]) without comment renders the phrase "au-dessus de pubis."

<sup>5</sup> Helmreich brackets *ἢ νῦν ἐστὶν* found in Kühn's text.

<sup>6</sup> Reading *ἐξηγησώμεθα* with Helmreich for the *ἐξηγησόμεθα* of Kühn's text.

<sup>7</sup> Kühn omits *πραχέως*.

# ON THE USEFULNESS OF THE PARTS

be ejected as far as possible. For if the channel does not lie in a straight line because it is bent or collapsed at some point, the semen is checked there. Thus, since in so-called hypospadiacs the channel is twisted by the ligament at the end of the penis, these are unable to beget, not, of course, because they do not have fertile semen, but because it is checked in the bends of the penis and cannot go on its way. The cure is consistent with this explanation; for when the ligament is cut, they do beget. Now this defect would always afflict everyone, if Nature had not provided a way for the channel to become broad and perfectly straight in coitus. There is another, second device employed by Nature to make this same change, namely, the position of this sinewy (nervous) substance itself and the juxtaposition of the muscles on each side. For the channel for the semen extends longitudinally in the lower parts of the penis and is centrally located. Upon it lies the hollow nerve [the corpus cavernosum], and at each side of it are two muscles [*bulbocavernosus* and *ischiocavernosus*], which are to broaden the channel by pulling upon it in both directions as if they were hands, while the whole penis remains without bending. And of course such a construction would also tend to keep this channel straight. It is useful, then, for the channel to be kept very broad and perfectly straight during the evacuation of the semen in order that the whole mass of it may reach the sinuses of the uteri all at once and as quickly as possible.

Moreover, since the bladder had been placed near by, it was not better to make a second channel for the excretion of urine but rather to use again the one for the semen. Properly, too, the neck of the bladder has occupied the whole region of the perineum, passing up from the anus, upon which it rests at first, as far as the place where the pudendum grows out. In women the neck of the bladder does not extend so far because the pudendum does not project; rather, it is the female pudendum itself that rests upon the anus, and the neck of the bladder comes to an end at the upper [anterior] side of the pudendum and pours out the urine there, having no need to be either very much bent or as long as it is in man.

As for the outgrowths of skin at the ends of the two pudenda, in woman they [the labia majora and minora] were formed for the sake of ornament and are set in front as a covering to keep the uteri from being chilled; in man it was impossible not to have them at all, if we remember any of my previous discussions in which I

# FIFTEENTH BOOK

showed how male and female animals are formed,<sup>8</sup> and besides, they [the prepuce] serve as an ornament. The part called *nympha* [the clitoris]<sup>9</sup> gives the same sort of protection to the uteri that the uvula gives to the pharynx; for it covers the orifice of their neck by coming down into the female pudendum and keeps it from being chilled. These, then, are the parts of the instruments of generation, and anyone even without my help can discern how marvelously they have been constructed in respect to their size, form, combination, and all other attributes.

4. It is hard to explain clearly the things that Nature has artistically devised for the animal while it is still in the uterus, as she forms it, brings it nutriment and pneuma from the mother, and makes ready good places for the residues, but certainly if these things are accurately observed in dissection, they at once force the beholder to admire them. There is a thin membrane called the amnion, which is placed all around the fetus and receives from it something like sweat.<sup>10</sup> Outside this lies another, thinner one which they call the allantois, and this is connected by a passage with the bladder of the fetus and collects within itself something like urine from the fetus up until birth. Round about these<sup>11</sup> is placed the chorion, lining the whole inside of the uterus, which consequently nowhere comes in contact with what lies beneath, and it is by means of this chorion that the fetus is attached to the mother. At the mouth of each of the vessels which extend to the inner side of the uterus and through

<sup>8</sup> That is to say, the female has the same parts as the male, differing only in arrangement because the male is hotter than the female. See chapter 6 of Book XIV.

<sup>9</sup> Lachs (1903, 16) says that Galen makes no mention of the clitoris, but the word used here, *νύμφη*, is defined by Rufus of Ephesus (1879, 147) as "the muscular bit of flesh in the midst, which some call the *hypodermis* and others the clitoris (*ἡ κλειτορίς*)."  
*νύμφη* is used again in the same sense by Galen in *Introductio seu medicus*, cap. 10 (Kühn, XIV, 706), a work attributed to him, but of suspected origin.

<sup>10</sup> The following description of the fetal membranes and umbilical cord certainly does not fit conditions in man, where the allantois never escapes from the body stalk, the placenta is discoidal, and the umbilical cord contains two arteries but only one vein. Galen is obviously describing conditions in some ruminant, the goat, perhaps, since in *De anat. admin.*, XII (Galen [1906, II, 106 ff.; 1962, 116 ff.]), where a similar description is found, he says that he is describing the goat.

<sup>11</sup> Reading *τούτοις* with Helmreich for the *τούτω* of Kühn's text.

## ON THE USEFULNESS OF THE PARTS

which the menstrual blood passes into it, another vessel is generated in pregnancy, an artery at the mouth of an artery and a vein at the mouth of a vein, so that the number of vessels generated is the same as the number of mouths that penetrate to the inner side of the uterus. Binding these vessels together there is a membrane, thin but strong, that grows around all the vessels on the outside and is inserted into the inner parts of the uteri. In all the parts between the mouths this membrane is stretched double beneath the uterus, and it branches off with all the vessels I have mentioned and accompanies them, each side of it clothing half of each vessel in such a way that this double membrane is a covering and protection for them and binds them to one another and to the uteri.

[II, 348]

Where it first grows out from the uterus, each vessel is small, like the extremities of the roots of a tree where they taper off into the earth. After the vessels have advanced a little, they come together in pairs, and when the two have become one, each of these [new] vessels in turn comes together with another of the same kind,<sup>12</sup> a process which does not cease until all the small vessels have been united into two large ones like trunks, that grow down into the fetus through the region of the umbilicus. There are in all four vessels there, two arteries and two veins, for no vessel combines with another of the other kind, veins always coming together with veins, and arteries with arteries. Hence this must now seem to you a primary work of Nature's, even if I do not say so; for it is proof of marvelous skill, not of unreasoning chance, that in the course of such a long journey, when so many vessels are mixed up together, no vein has ever yet been found implanted in an artery, nor any artery in a vein, but [each] always recognizes the vessel that is suitable and unites with this alone.

Is it not also an indication of marvelous foresight that in animals which naturally leap a great deal, like deer and goats,<sup>13</sup> the out-

<sup>12</sup> *ὁμογενῶν*, having the same origin, that is to say, a vein formed by the union of two smaller veins unites with another vein similarly formed, and the arteries behave in the same way.

<sup>13</sup> I can account for this singling out of the deer and goat only by the fact that whereas the cotyledons of other ruminants, the cow for example, are convex and even stalked, those of the deer are much flatter; the goat's are actually concave, and the fetal half of the cotyledons covering the dichotomous arrangement of the chorionic villi seems thicker. See Bolk, Göppert, Kallius, and Lubosch (1933, VI, 192-195).

## FIFTEENTH BOOK

growth of the vessels is joined to the uteri not just with thin membranes, but also with viscous flesh like grease? Indeed, the fact that no vein or artery is inserted into the fetus at any place other than the umbilicus, which occupies the middle of the entire animal, is in itself a mark of no common skill. Is it not marvelous too that the veins do not pass by the liver to be inserted into some other viscus and that the arteries do not go to some other place instead of being carried to the great artery,<sup>14</sup> which grows out from the heart itself? And it is a token of no mean skill that the interval between<sup>15</sup> is not determined by chance and that the vessels are not inserted into these instruments at any random places, but that the veins are inserted into the concavity of the liver and the arteries into the part of the great artery at the loins. Now one can see that as soon as the veins have passed the umbilicus, they come together and become one vein, which is then invested with strong membranes and bound up with the adjacent bodies until it reaches the viscus. For it must arrive first at the source of the veins in the fetus and then be distributed from that point in every direction. [II, 349]

The arteries, of course, must be inserted into the source of the [fetal] arteries, that is, into the left ventricle of the heart, but since this has been moved very far up from the region of the umbilicus, it was dangerous to bring the arteries up, suspended as it were, over such a long road. What, then, was left to be done that would be any better than to bring them over the shortest distance to one of the vessels growing out from the heart? Well, there is the largest artery [the aorta] which grows out of the heart and lies along the middle of the spine, occupying the whole length of it, and so it was necessary to make the arteries coming from the uterus to the fetus open into this and be attached to it. In fact, this is where they do arrive and are attached, and here too Nature has obviously done nothing in vain. [II, 350]

Why, then, did she not bring them along by the shortest path to the great artery? For the shorter path is the safer and the one Nature herself more often employs, as I have shown in preceding books. Or must we in this instance too admire her foresight? For when paths have no other advantage over one another, she chooses the shortest, but when greater safety is gained from using a longer route than is to

<sup>14</sup> That is, into its branches, the common iliac arteries.

<sup>15</sup> This rather clumsy expression apparently means the distance between the umbilicus and the insertions of the vessels.

## ON THE USEFULNESS OF THE PARTS

[II, 351]

be had from a shorter, she does not hesitate to go around by the longer way. Certainly in this case it is obvious that she has chosen instead of the short, dangerous path one that is longer but perfectly safe. Indeed, with good reason she avoided leading the arteries straight from the umbilicus to the spine, whether they persisted as two or even if they became one, since they could not rest upon any instrument for any part of the journey, and since too this region was already occupied by the intestines and kidneys. However, because the bladder was near at hand, as it is particularly in the fetus, where its fundus is adherent to the region of the umbilicus, the arteries could easily mount upon it and, descending along the whole bladder as if it were a sort of ladder, make their way to the great artery. They did not, however, simply mount upon it; for, carried on a convex surface, they would not hold steady unless they were bound to it in some way. Hence Nature attached them to the bladder, each on its own side, with strong membranes and so, being now, as it were, a part of the bladder itself, they are conducted safely as far as the great artery. Such is the foresight with which matters have been arranged for the arteries.

Why is the vein inserted not into the convex part of the liver, but into its concavity? The reason is that the vessel of the bile had been placed there, and it was better for the blood to be purified before being distributed to the whole animal. And why were the veins themselves united immediately after passing the umbilicus, whereas the arteries remain paired for a long distance? Is it not because it was safer for the veins to come together and make one larger vessel? For a larger thing is always less liable to injury, and the vein had to be inserted into a single part of the liver. The arteries, on the other hand, which were to be carried safely upon the bladder and which do not arrive, immediately at least, at the left ventricle of the heart, were under no necessity to be made one. Doubtless, if Nature had conducted these up without support to the heart, as the veins are conducted to the liver, she would straightway have united them too.

[II, 352]

5. There are four of these vessels, then, at the umbilicus, two arteries and two veins, with the urachus in their midst. For the urachus is what anatomists are wont to call the canal from the fundus of the bladder which draws the urine off into the allantoic membrane that I mentioned a little while ago, so called because it is shaped like a sausage (*ἀλλᾶς*). Of the four vessels surrounding

## FIFTEENTH BOOK

the urachus, the veins are on the upper side, since it was better for them to go straight up to the liver, and the arteries are on the lower side, because it was better for them to pass downward, supported on the sides of the bladder. Thus Nature has at once established each pair of vessels in a suitable place, and through them, as if through trunks, the embryo attracts blood and pneuma from the uterus. Between all these trunks and the little vessels inserted into the uterus itself there is a sort of rooting of the trunks, and it is this rooting that is called the chorion, being a multitude of vessels which cannot easily be counted and which are joined together with a thin membrane. I have said before that this membrane is double and told why; for all the vessels of the chorion pass through the midst of it [between the layers] and are held together and covered by it.

Of the other two membranes, the one called allantoic, which I have said opens into the bladder by way of the urachus, was prepared as a receptacle for the urine, because it was far better that the fetus should void its urine not at the pudendum but at the umbilicus, as it actually does. In fact, since the membrane called the amnion surrounds the entire fetus and receives the other kind of liquid, it was not reasonable to mingle the urine with such a one as this.<sup>16</sup> It clearly appears that the liquid in the allantois is not only thinner and yellower than that in the amnion, but also more acrid, so that it grievously offends with its odor those dissecting the membrane. The fluid on the order of sweat that accumulates in the amnion is poured all around the fetus, since it cannot harm the skin. The urine, however, is led off and kept separate, coming in contact neither with the skin nor with the veins of the chorion, so that none of the neighboring parts may be injured by its acridness.

[II, 353]

The fluid in the amnion, on the other hand, is of considerable use; for the fetus, as if swimming in it, is lifted and held up so as to be less heavy for the cords that attach it to the uterus. And this was the thought in Hippocrates' <sup>17</sup> mind when he said, "When pregnant women miscarry at two or three months for no apparent reason, their cotyledons are full of mucus and cannot support the weight of the fetus but break off." What he calls cotyledons are the mouths of the vessels arriving at the uterus (for I have shown this in other

[II, 354]

<sup>16</sup> "Such a one as this," is the amniotic fluid, called by Galen at the beginning of chapter 4, "something like sweat."

<sup>17</sup> *Aphorismi*, sectio V, 45 (Littre, IV, 548, 549).

works of mine)<sup>18</sup> and he says that when they have become somewhat charged with mucus, they are not able to hold and support the embryo, but give way and are broken off by the weight. In fact, this would happen to all pregnant women if the fetus were not made lighter by swimming in the fluid of the amnion and if the downward pull exerted on the union of the vessels with the uterus were not lessened. But those who say that by swimming in the fluid of the amnion the fetus becomes lighter for the mother [to carry] are utterly ridiculous, because they do not understand that she also supports the fluid itself.

[II, 355]

These fluids have in addition another, common usefulness, which is manifest at the birth of the animal, namely, that the fetus when moistened by abundant fluid issues more easily from the neck of the uterus; for at that time the membranes necessarily rupture. And not only is the moisture useful for making the fetus slippery, it also prepares the neck of the uteri to dilate easily and to its greatest extent; for, bathed in these fluids, it becomes softer and is more easily dilated. The best proof of what I have said is that when the fluid flows out ahead of time all at once, the midwives themselves have to imitate Nature by introducing some liquid to soak the neck of the uteri. Surely the works of Nature are altogether ingenious, and, as I have shown many times, she makes additional use for the better of all the things that will otherwise exist of necessity. Thus, although these fluids surrounding the embryo were engendered necessarily, she also used them in order that the fetus might be carried painlessly and might be readily expelled at birth.

If the membranes are so thin and so like cobwebs that they are easily torn in dissection unless you handle them gently,<sup>19</sup> how is it, then, that they are not torn at times when the mother runs and jumps? Here too is one very clever device of Nature's, who knows that it helps most in making all thin bodies resistant to injury if they are applied one to another. Materials woven of interlaced woolen threads or some other fibers or hairs gain the greatest strength from this composition, though each of the components by itself is naturally very weak. If, then, the components are not only associated

<sup>18</sup> In *Hippocratis Aphorismi et Galeni in eos commentarii* (Kühn, XVII, pt. 2, 838), *De semine*, I, 7 (Kühn, IV, 537-538), and *De uteri dissectione* (Kühn, II, 902-906; Galen [1962a, 81-82]).

<sup>19</sup> *μερπλως*, moderately.

with one another (as in these materials that we weave and interlace) but also perfectly united as well, their strength is multiplied many times by this union. Hence it is nothing wonderful if four<sup>20</sup> membranes lying one upon another gain strength from this composition, but it is most wonderful that they not only rest upon one another but have also grown together in many places and in many others are knit together by slender, fibrous processes; for Nature wished to unite them as much as she could in order that they might all get from one another the strength that was wanting in each one by itself. But (perhaps someone will reply) why, then, did Nature not make each of them strong right from the beginning, seeing that she provides for the resistance to injury of all the parts? The reason is that if she had made them thick and hard—for she could not bestow strength upon them in any other way—she would have hung upon the mother a weight of very great mass, which not only would be distressing to her, but would also unnecessarily narrow the space for the fetus. Moreover, each membrane would become hard to break through at birth. So in order that all the space in the uterus may be left free for the fetus, that the mother may not be wearied by so much weight, and that the membranes may rupture easily at birth, Nature has properly made them all thin, but has devised safety for them by joining them to one another.

[II, 356]

What is the device that she employs (for this remains to be told) to ensure that, although the neck of the bladder already has the channel which the animal uses to urinate after birth, none of the urine will pass into this [during embryonic life] and all of it will ascend to the umbilicus and urachus? For when the bladder has an outlet on each side, the urine does not have to be evacuated at the urachus rather than at its neck. What physicians have said on this subject is extremely absurd, though plausible enough when one first hears it. For, accepting these two things as agreed upon by common consent, namely, that our excretion of urine is under the control of our will, and that the fetus does not yet make use of such actions, they conclude from these that there is good reason for the urine to be excreted at the umbilicus, since of course no muscle like the one at the neck of the bladder has been established at the umbilicus to serve the animal's voluntary action. Most important considerations

[II, 357]

<sup>20</sup> The supposed two layers of the chorion together with the amnion and allantois.

[II, 358]

have escaped these men, however, and they are entirely mistaken, because they do not know either that this muscle does not have the office of constricting the neck of the bladder,<sup>21</sup> or that the fetus does not yet make use of voluntary actions, or that when the perfected animal chooses to urinate, it does not relax this muscle established at the urinary channel and release its tension in the same way that it relaxes those at the anus when it wishes to empty the bowels. For excretion takes place when the bladder naturally contracts upon the fluids within it, and when we choose to void a larger quantity of urine quickly, the epigastric muscles too assist. But I have said enough about these matters in my commentaries *On the Natural Faculties*<sup>22</sup> and *On the Movement of the Muscles*,<sup>23</sup> and in my *Manual of Dissection*.<sup>24</sup> And in my commentaries *On Demonstration*<sup>25</sup> and *On the Teachings of Hippocrates and Plato*, I have said that what is contained in the uterus is already an animal, at least when all its parts have been formed.<sup>26</sup> Even if it were not an animal that is contained in the uterus, the matter would be just as difficult; for the muscle closing the mouth of the bladder will be idle. Moreover, when the bladder contracts around the fluid in it, it is reasonable that excretion should take place to some extent through both channels, not just through the one at the umbilicus.

Such, then, is the difficulty in the argument; Nature's work itself, however, shows in every respect her inventiveness, and as soon as you see this in the dissection of embryos, you can discover the cause<sup>27</sup> by reasoning. Now when you have divided the peritoneum

<sup>21</sup> See chapter 16 and note 55 of Book V.

<sup>22</sup> *De nat. fac.*, I, 13 (Kühn, II, 30-38; Galen [1928, 48-61]).

<sup>23</sup> *De motu musculorum*, II, 8 (Kühn, IV, 454-458).

<sup>24</sup> *De anat. admin.*, VI, 14 (Kühn, II, 584-588; Galen [1956, 169-171]), XII (Galen [1906, II, 120; 1962, 130]).

<sup>25</sup> A lost work and one of Galen's earliest; see Kühn, I, *cxcvi*, and Walsh (1935, 579-589; 1936, 65-71).

<sup>26</sup> I have not found this idea stated explicitly in *De placitis Hippocratis et Platonis*. Perhaps it was included in the first four chapters and part of the fifth of Book I, which have not come down to us. In several places, however, such a belief is implied. See Books II, 8, V, 6, and VI, 6 (Kühn, V, 277, 465-466, 555-560). There is also the spurious work, *An animal sit id, quod in utero est* (Kühn, XIX, 158-181), which may yet to some extent reflect his point of view.

<sup>27</sup> That is, the reason why the urine is excreted through the urachus rather than the urethra.

lying in front of the bladder, do these two things at the same time: raise the umbilicus, and compress the contents of the bladder by grasping it with the hand. You will then see the urine run out into the allantois through the channel at the umbilicus. Furthermore, if in turn you compress the allantois itself, you will fill the bladder, and then by compressing the bladder again you will fill the membrane, and what has happened will itself teach you that it is because of the straightness and size of the channel at the umbilicus that the urine flows out first through it. For the urachus is many times as wide as the neck of the bladder, and so far as straightness is concerned, they cannot justly be compared; the neck of the bladder is very much bent and the urachus is perfectly straight, because of course the whole umbilicus is raised and suspended, as it were, from the uterus by the vessels of the chorion. Moreover, no muscle has been placed around the outside of the urachus to guard against an untimely escape of the residues, as the muscle at the neck of the bladder does after birth. In fact, there is no unsuitable time for the fetus to excrete such a residue, as there is for [animals] already perfected. For the latter a muscle has with good reason been established to allow nothing to pass except at the bidding of reason, but in embryos this would be superfluous and in vain—and Nature does nothing in vain.

[II, 359]

6. Now that I have said enough about these matters, let us turn to the other features of the embryo's construction in which it differs from animals already born and explain Nature's skill as displayed in these. Among them, not the least worthy of admiration will be the large size of the liver right from the beginning, as soon as it is possible to distinguish clearly that each of the fetal parts has been formed, and this also holds true up to the time of birth. Indeed, in the first periods the liver predominates to a greater degree in comparison with the other parts, and much of this predominance lasts till birth. Next in order, the encephalon and heart are proportionally larger than the other parts, and this happens because the liver is the source of the veins, the heart of the arteries, and the encephalon of the nerves. It was reasonable, then, that just as craftsmen first make firm the foundations of a house, the groundwork of a temple, and the keel<sup>28</sup> of a ship and afterwards rear their structures safely on these foundations, so in animals Nature should in the same way

<sup>28</sup> See note 10 of Book III.

[II, 360] cause the different kinds of vessels to grow out, each from its own proper source already safely established, and extend them into the whole body. Since the fetus, being governed for a very long time like a plant, gains a greater advantage (*χρεία*) from the veins, she made the source of these very strong right from the beginning of its generation; for the encephalon, the heart, and the instruments that have grown out from them must have the advantage provided by the veins, because without blood they cannot either be generated or grow, whereas before the liver and veins are perfected, they have little need (*χρεία*) for arteries and none at all for nerves. This, then, is the reason why Nature made the veinlike kind [of instruments] strong and large right from the beginning and then began to enlarge each of the others in turn.

[II, 361] Why is the lung red in animals while they are still fetuses, and not whitish as it is in perfect animals? The reason is that it is nourished at that time like the other viscera, by vessels [*vv. pulmonales*] having a single, thin tunic; for during gestation blood reaches these vessels from the vena cava. In animals after birth, however, the passageway [the foramen ovale] connecting the vessels [with the vena cava] is stopped up, and a great deal of pneuma falls into them, but very little blood, and that extremely thin. Moreover, the lung is then kept in continuous motion as the animal breathes, and thus the blood, dashed about by the pneuma in the double motion which it has from the arteries and acquires from the lung, becomes thinner and softer than it was, and like foam. For this reason the nature of the lung's flesh changes from being red, heavy, and dense to become white, light, and loose-textured, and this, as I think I have said, is a most useful thing for the lung as it follows the thorax in the movements of respiration; for its weight would make it hard to move if it had received a flesh like that of the other viscera. And so it is right to admire Nature here too, because when the viscus needed only to grow, she supplied it with pure blood, and when it was changed so that it moved, she made its flesh light as a feather in order that it might be easily dilated and compressed by the thorax. This is the very reason, then, why a passageway [the foramen ovale] was made connecting the vena cava and the venous artery [*v. pulmonalis*] in the fetus. Inasmuch as this vessel, however, serves as a vein for the viscus, it was necessary, I suppose, for the other one [*a. pulmonalis*] to change into the usefulness of an artery, and therefore Nature also

connected this one to the great artery [the aorta], but in this case, because there was a space between the vessels, she created another, small, third vessel [the ductus arteriosus] to join the two. Since the other two vessels [the vena cava and *v. pulmonalis*], however, were in contact with one another, she cut a sort of hole [the foramen ovale] that was common to both and devised a membrane there, like a lid readily pushed back toward the vessel [*v. pulmonalis*] of the lung, so that it might yield to the rush of the blood flowing to it from the vena cava but prevent the blood from coming back into the vena cava again.

Well, all these works of Nature are admirable, but beyond all admiration is the later closing of this aperture I have mentioned. For in animals either just born or a day or two old, and in some that are four or five days old and on occasion even older, it is possible to find the membrane at the aperture uniting with it, but not yet [fully] united. When in an animal that has been perfected and has reached its prime of life you see the whole place accurately sealed, you will not believe that there was ever a time when it was pierced through. On the other hand, if in fetuses and newborn animals you see the membrane supported only at its root and the whole body of it swinging free in the cavity of the vessels, you will [be] much more [inclined to] think it impossible that it will ever admit of an exact union. Even if one attempts to unite sinewy, thin bodies immediately after they have been divided, he will not succeed, and still less, of course, if they have hardened<sup>29</sup> after a lapse of time. Yet that membrane attains an exact union as time goes on, and is not prevented from doing so by being sinewy and thin or by being continually moved and shaken. So too, although all the other parts are growing, the vessel [the ductus arteriosus] connecting the great artery to the vein of the lung [*a. pulmonalis*] not only does not grow, but also obviously becomes more and more slender, so that in the course of time it wastes entirely away and dries up. That Nature has accomplished all such things with skill is indicated by the usefulness found in each of them, and the power by which she does this is beyond our finding out; for we do not even have any faith at all that a thing is possible, unless we have seen it plainly and often. But I shall now stop writing about these matters, since I have told about

<sup>29</sup> Reading *τυλωθέντα* with Helmreich for the *τελεωθέντα* of Kühn's text.

them on a few occasions earlier in my discourse, when I was discussing the instruments of the pneuma.

[II, 364] 7. I shall recall to you a certain other work of Nature's, equally wonderful, but known to everyone even before dissection. For there is no one who does not know about the orifice of the uteri, how it is accurately constricted and closed during the period of pregnancy, and how it opens to its greatest extent at the time of birth. This birth takes place when the fetus has already been perfected so that it can be nourished by mouth. During all the remaining time it is impossible to introduce even the head of a probe into the neck of the uteri, but at birth the whole animal comes out through it. Hence, just as we see clearly that the membrane [of the foramen ovale] mentioned just now unites with the vessels though it passes human comprehension how this happens, so too in regard to the uteri everybody knows that their orifice opens widely enough to provide easy egress for the embryos, but we can do no more than wonder how it happens. Nature, however, has contrived remarkable devices for this and everything else that has to do with birth. For by putting the head of the fetus first, next to the neck of the uterus, and by making with it a way for the other parts, she took great care to see that the fetus should approach the neck of the uterus in the right way and should come out through it without hurting any limb or dislocating any member. Indeed, if the embryo should approach the exit obliquely or crosswise, or if it should come longitudinally, but not as it actually does,<sup>30</sup> either it would not fit into the [canal] at all,<sup>31</sup> as happens sometimes, though rarely, or a leg or arm, fitting into it<sup>32</sup> before the head, would make the exit difficult for the other members. Now if the emergence were to take place<sup>33</sup> properly three or four times [in comparison to] once when birth was impeded, it would then follow that out of four hundred embryos, for example, one hundred would have difficulty. But since this is seen to happen only once in many thousands of births, it should serve to remind us of the good things that we enjoy from the Craftsman who formed

<sup>30</sup> That is, if it should emerge feet first.

<sup>31</sup> Reading *ἤτοι τὴν ἀρχὴν* with Helmreich for the *ἢ κατὰ τὴν κεφαλὴν* of Kühn's text.

<sup>32</sup> Reading *ἐναρμυσθέντα* with Helmreich for the *ἐκπίπτου* of Kühn's text.

<sup>33</sup> Kühn adds a negative here.

us, and should make us realize clearly not only his wisdom, but also his power. For what Phidias or Polyclitus<sup>34</sup> is so good a creative artist as to make but one mistake in many thousands of works [II, 365] difficult of execution?

Then is it right to praise Nature only for these things, or has the greatest wonder of them all—the instruction of the animal being born in the actions of all the parts—not yet been told?<sup>35</sup> For not only did she prepare a mouth, esophagus, and stomach as instruments of nutrition; she also produced an animal that understands right from the beginning how these are to be used, and she instilled into it a certain instinctive faculty of wisdom by which each animal arrives at the nutriment suitable for it. I shall explain all the other animals at another time. For man she prepared milk as nutriment, producing two things at one appointed time, nutriment in the breasts of the mother, and in the infants to be nourished an eager desire for such a juice. Now if the nipple of a breast is put into the mouth of a newborn child, he immediately compresses it with his lips, immediately draws in the juice by opening his jaws, and then by curving his tongue pushes it down into his throat, as if he had practised this for a long time. Thereupon, the esophagus transfers it into the stomach and does so as if it had been taught; next the stomach, after having the benefit of the juice, passes on what is left to the intestines, and these then transmit it from one to another till it reaches the last. Next in store for the infant is the production of teeth, so that he may not be a perpetual burden to his mother, and with them comes the action of chewing, self-taught, like the others. Everything else [II, 366] follows in its turn, but the explanation of it all is another story. And now, since I have finished what I proposed with the exception of a few things, it is time to pass on to these.

8. What remains of the entire treatment of the subject is to tell about the muscles which move the diarthrosis at the hip and about which I have said nothing at all, and to devote one book to the instruments common to the [whole] body, that is, to the arteries,

<sup>34</sup> Architect and sculptor of Sicyon, who flourished in the fifth century B.C. and is known for the beauty of proportion achieved in his work. He is famous for his statue of an athlete so perfectly proportioned that it is called the Canon. See chapter 1 of Book XVII, and cf. *De temperamenti*, I, 9 (Kühn, I, 566).

<sup>35</sup> But see chapter 3 of Book I, where this point has already been made.

## ON THE USEFULNESS OF THE PARTS

nerves, and veins. The next book after this, being the sixteenth [counting] from the beginning, will take up the argument concerning these, but let us speak now of the muscles moving the joint at the hip. I have told in the thirteenth book why this must be useful for less varied but safer movements than the shoulder joint. Moreover, as regards the bones themselves, I have told in the third book what their nature is and how they are very well constructed in view of the action for the sake of which they were made; for the similarity of the subjects led me to a common discussion of them, but I shall speak in this book of what is peculiar to the joint at the hip alone and cannot be explained in conjunction with any other.

[II, 367] Nature has created the legs as instruments for walking, four of them for the horse, dog, beef, and all such animals, but man alone among animals that go afoot has two. The ape has legs like those of the human infant just trying to use them for the first time, and in fact, the ape both goes on all fours like a quadruped and uses its anterior limbs as hands. When a man is grown, he no longer uses his anterior limbs as feet, but the ape forever plays a double game, being constructed for two things, both to clamber up swiftly, like creeping animals, and to run unsteadily, like a little child; for it could not be well constructed for both things. Hence the digits of its feet were very deeply divided from one another and some of the muscles moving the knee joint were brought low down on the tibia.<sup>37</sup> So too in this animal the character of the hip joint approaches that of the joint in man, but they are not exactly alike, just as the hand and arm [also fail to resemble their human counterparts]. Furthermore, the fleshy muscles [*glutei*] forming the buttocks are, like all its other parts, ridiculous; for I have shown that the animal is a ludicrous imitation of man. In man they are beautifully arranged both for the decency of the necessary parts and for keeping the anus compressed and painless in the act of sitting. Since these muscles alone are undersized in the ape and all the rest are arranged very much as they are in man, test in the ape the account I shall give of the muscles moving the joint at the hip; for anatomists before my time have used this animal to teach the subject of these muscles. But just as they have overlooked many, many other things, throughout the body, so

[II, 368]

<sup>37</sup> Particularly biceps femoris; see chapter 16 of Book III and also *De anat. admin.*, I, 2 (Kühn, II, 222-223; Galen [1956, 3-4 and Singer's note 24]).

## FIFTEENTH BOOK

here too there are whole muscles which they failed to see. I myself have written a special, separate treatise *On the Dissection of the Muscles*<sup>37</sup> and have also explained in my *Manual of Dissection* how many muscles there are in this region and what their forms are, while at the same time I indicated the reasons why my predecessors have gone wrong in regard to them.<sup>38</sup>

Since, then, this joint had to be flexed when the leg was raised and extended when it was set down, and since these movements constitute its most important action—for it is less useful to bring the leg inward toward the other leg and move it outward and away again, and still less so to rotate it in either direction—anyone might immediately demonstrate the skill of Nature from the differences in the size and number of the muscles. For she has made the ones that extend and flex the limb largest and most numerous, those that move it laterally next after these in size and number, and then the ones that rotate it even smaller and fewer. Thus the first classification of the muscles is properly held to be threefold and is determined by the usefulness of the movements. When I have divided each of these three classes again into two parts, I shall explain the superiority of the muscles in the more useful division. Now the flexor muscles have been made smaller and less numerous than the extensors; the adductors are smaller and less numerous than the abductors; and those that rotate the femur are of about equal value.<sup>39</sup> These are the main points of my discourse; let me now give the demonstrations of them.

[II, 369]

The actions of the legs, those for which they were made, are walking, running, and standing. Walking and running are accomplished with the legs in opposition to one another, whereas in standing they are placed alike. In standing each leg is supported by the ground and they are equally tensed, but in walking and running one is supported while the other is carried past it, and the one that remains firm exerts the greater effort.<sup>40</sup> In fact, the leg that is carried past moves only itself, but the one that is supported not only tenses

<sup>37</sup> *De musc. diss.* (Kühn, XVIII, pt. 2, 1000-1007; Galen [1963, 494-496]).

<sup>38</sup> See note 29 of Book II.

<sup>39</sup> That is to say, the muscles rotating the femur in one direction are about as large and numerous as those rotating it in the other.

<sup>40</sup> Cf. chapter 5 and note 16 of Book III.

## ON THE USEFULNESS OF THE PARTS

itself directly but also carries the whole body, bearing a weight double the one it bore earlier, when the legs were standing. Now in carrying the leg past [the other] the muscles flexing it are the more active, but in standing the muscles that cause extension remain strongly tensed, because, if they relaxed even a little, the animal's whole body would be in danger of collapsing. The leg is bent at the groin when we lift it, and if you wish to keep the limb in this position, the flexor muscles must be tensed. It is extended when we put it down on the ground and has its greatest extension and most extreme tension when we are standing.

[II, 370]

Hence Nature with good reason entrusted this work to many large, strong muscles; first, to the one [*gluteus maximus* and *tensor fasciae latae*]<sup>41</sup> which covers the whole joint at the rear and corresponds to the one [*deltoideus*] at the shoulder; second, to the one [*gluteus medius*] following this, which arises from all the outer sides of the bone of the flank [*os ilii*] and is inserted into the highest part of the great trochanter, occupying also a little of the anterior part; third, to the one [*gluteus minimus*] next after this, which grows out from the outer and lower portions of the bone of the flank, is implanted into the first, inner parts of the great trochanter, and then also grows around the anterior parts of it; and fourth, besides these, to the one [*piriformis*] growing out from the broad bone [*os sacrum*] and inserted into the great trochanter from its entire posterior part as far as the summit. The first one mentioned of all these exerts a strong, straight extension when it draws up the femur by its two extremities [that is, by the extremity of *gluteus maximus* and that of *tensor fasciae latae*], but if you tense only one of these, it causes no longer a straight upward pull but one inclined to the side. The second muscle raises the head of the femur and at the same time draws it toward the inside [medially]. Each of the other two raises it slightly; one of them [*piriformis*?] rotates it outward, the other [*gluteus minimus*?] rotates it inward, [and they do so] a little more than they raise it, but much less than the other muscles [*obturatores externus* and *internus*] which have the same work and which I shall explain last.

[II, 371]

For now I shall go on as I have begun and speak first of the

<sup>41</sup> *Gluteus maximus* and *tensor fasciae* are fused anteriorly in the ape. See Howell and Straus (1933, 149-150).

## FIFTEENTH BOOK

extensors, next of the flexors, and then of those producing lateral motion. But since the motions of most muscles are composite because Nature, as I have already said many times, is careful always to produce for animals many actions with few instruments, I shall therefore necessarily mention among the muscles extending the leg those that produce some other, additional motion. The first [*gluteus maximus* and *tensor fasciae latae*] of all the four muscles I have mentioned, the one which I have said is analogous to the one at the shoulder and which extends the leg by means of two insertions, produces a perfectly straight motion when it acts with both these, but a motion very slightly inclined to the side when it acts with only one of them. So too the muscle [*gluteus medius*], mentioned as the second, extends and at the same time draws slightly inward [medially] the head of the femur. Similarly, the third [*gluteus minimus*] and fourth [*piriformis*] extend it very slightly, as I have said, and rotate it a little more. Besides these muscles, there is another, fifth one [*adductor magnus*],<sup>42</sup> which is the largest of all the muscles in the body and which clings to the whole bone of the thigh on its inner and posterior parts as far as the knee. The posterior fibers of this muscle, which arise from the ischium, hold the leg firm as they extend the diarthrosis. The fibers that grow out along the lower parts [of the muscle] from the pubic bone also do this just as much, along with a very slight movement inward [adduction]. The fibers that are higher than these adduct the femur, and in the same way the highest of all adduct it and at the same time draw it up.

[II, 372]

The flexors of the diarthrosis are opposed to these five muscles and are fewer and smaller than they. There is the muscle [*psaos major* and *iliacus*]<sup>43</sup> that comes straight down from above from a double origin and is inserted by a single tendon into the summit of the small trochanter. Accompanying this is the muscle [*pectineus*] that is inserted into the same trochanter lower down but has its origin from the anterior parts of the pubic bone, and beside it is placed another, oblique one [*adductor brevis*], which is like a part of the largest

<sup>42</sup> Apparently, *adductor longus* is also included and perhaps *quadratus femoris* as well. *Vide infra* and see note 49.

<sup>43</sup> In the ape these two muscles meet and fuse before they pass over the brim of the pelvis. See Howell and Straus (1933, 149).

## ON THE USEFULNESS OF THE PARTS

[II, 373]

muscle [*adductor magnus*] and has a similar action. The fourth muscle<sup>44</sup> [*rectus femoris*] extends the diarthrosis at the knee by the aponeurosis passing over the kneecap. This muscle incidentally<sup>45</sup> flexes the femur, but the other three do so as their principal action; the one [*psoas* and *iliacus*] coming down from above [also] inclines it inward [rotates it medially] a very little; those [arising] from the anterior parts of the pubic bone [*pectineus* and *adductor brevis*] incline it inward a great deal and draw it up slightly; but the fourth [*rectus femoris*], which I have said flexes the femur incidentally and was not made primarily for the sake of the joint at the hip, causes great upward tension and flexion, yet far less than the first named. For that one, taking origin from the loins [*psoas*] and from the inside of the bone of the flank [*iliacus*], extends to the small trochanter, whereas the one [*rectus femoris*] extending the diarthrosis at the knee, the action for the sake of which it was made, takes origin from the straight spine<sup>46</sup> of the bone of the flank [*os ilii*], and therefore, when it is tensed, it naturally not only draws up the tibia toward itself, but also flexes the femur; for of course, if it grew out from the lower side of the diarthrosis at the groin, it would move only the tibia. In fact, Nature acted providently in making this muscle grow out from above the diarthrosis at the groin in order to provide another, extra movement necessary to the animal.

The muscles adducting the femur are these: Two of those mentioned previously [*pectineus* and *adductor brevis*], that have their origin from the anterior parts of the pubic bone, are capable not only of adducting the member, but also of flexing it moderately. Another, third one [*gracilis*] is not to be compared with these<sup>47</sup> in length, for it is very long; it grows out from the anterior parts of the

<sup>44</sup> Kühn's Greek text omits *τέταπτος*, but the translation of it appears in his Latin text.

<sup>45</sup> κατὰ συμβεβηκός, accidentally.

<sup>46</sup> Probably not the anterior inferior spine of modern terminology, but the whole surface of the ilium above the acetabulum. From the way in which Galen goes on to speak of the origin of rectus femoris, it is evident that he was thinking of the one immediately above the acetabulum and overlooked the part arising from the anterior inferior spine. In the ape, as Keith (1894, 271) says, "The duplicity of the rectal origin may be easily overlooked, and was probably overlooked by those observers that record the absence of one head."

<sup>47</sup> Reading *τούτους* with Helmreich for the *τούτο* of Kühn's text.

## FIFTEENTH BOOK

pubic bone and lies alone the whole member as far as the knee, on the inner side of the head of which it comes to an end.<sup>48</sup> Moreover, the inner part of the largest muscle [*adductor magnus*] has the same action. The muscles moving the femur toward the outside [that is, abducting it] are one part [*tensor fasciae latae*] of the muscle [*gluteus maximus*] mentioned first of all and the muscle [*piriformis*] which arises from the broad bone [*os sacrum*] and which I have said rotates the femur slightly.

There remain two other muscles [*obturatores, externus* and *internus*]<sup>49</sup> that move it, and these have their origins one from the inner, and the other from the outer, parts of the pubic bone. Both wind around the part called the ischium and arrive at the same place, being inserted by strong tendons into a single concavity situated in the posterior parts of the femur, just where the great trochanter begins to grow out. Of all the muscles I have mentioned, these are the only ones which turn and rotate the femur by drawing it each one toward itself; for, as I said in my first enumeration of the muscles that extend the member, when these rotate it a little, they do so only secondarily and slightly, being formed by Nature primarily to extend the joint at the hip. All the muscles moving the femur have been said to have a number and size corresponding to the usefulness of the movements which they control, but along with number and size the usefulness of the origin and insertion of each muscle, and of its position between these points likewise at once becomes evident. For when they are drawn up toward their first origin, the extremity that is being pulled must draw the member along with it. Hence the muscle drawing the member up necessarily comes down from parts that are higher up, and muscles moving it laterally must originate

[II, 374]

<sup>48</sup> It was surely a slip on Daremberg's part (1856, II, 156) when he identified this muscle as rectus femoris. Cf. chapter 16 of Book III.

<sup>49</sup> Note the absence of any mention of the gemelli and quadratus femoris, which are also unmentioned in *De anatomicis administrationibus*. In the rhesus monkey the gemelli are combined in a single muscle sheet (see Howell and Straus [1933, 152]) and may possibly be referred to by Galen in *De musc. diss.* (Kühn, XVIII, pt. 2, 1006; Galen [1963, 496]), where he remarks that the obturators are attached to the ischium by fleshy slips. This seems especially likely in view of the fact mentioned by Keith (1894, 253) that "the fibres of the inferior gemellus may be continuous with the ischial fibres of origin of the obturator externus." Quadratus femoris, I suspect, Galen took to be part of adductor magnus.

## ON THE USEFULNESS OF THE PARTS

[II, 375]

from inner parts if their task is to move it inward, and from outer parts if they are to move it outward. Since the femur must be turned and rotated in some of its movements, Nature curves in a circle either the whole body of the muscles charged with this action or only their tendons. For straight muscles move members with simple motion, drawing them in a straight line toward those parts to which the heads of the muscles extend, but muscles whose whole bodies or even whose tendons are curved produce a motion that is circular rather than straight. Thus the two muscles [*obturatores*] named last, which are inserted on the great trochanter and which have a course that is oblique, not straight, toward the member to be moved, must control a motion that corresponds to their situation.

## THE SIXTEENTH BOOK OF GALEN ON THE USEFULNESS OF THE PARTS

### [The Nerves, Arteries, and Veins]

1. In the preceding explanations of the parts I have already spoken not infrequently of the instruments common to the whole body, that is, of artery, vein, and nerve, but I have thought it better not just to speak of them in scattered places but to bring together all that needs to be added into a single survey. It is clear that here too the discussion will have as hypotheses things previously demonstrated: that the encephalon is the source of the nerves, the heart of the arteries, and the liver of the veins. Since these instruments must be distributed to the whole body, give me your careful attention while I explain how justly this has been done. Now if it appears that larger ones have been given to some parts and smaller ones to others in accordance with the value of each part, and if this is found to hold true throughout the body, we shall commend Hippocrates for calling Nature just; and if they are seen to pass to each part in entire safety, we shall declare her to be not only just, but also skillful and wise. It makes no difference, of course, whether the explanation begins with the encephalon, heart, or liver; for the common statements concerning the three sources are necessarily made at the same time, the nature of the subject not permitting us to do otherwise even if we wished, and those<sup>1</sup> pertaining to each one separately can be finished in addition to the common ones previously discussed whenever one desires.

[II, 376]

What, then, are the common statements concerning the three

<sup>1</sup> Accepting Helmreich's emendation, *οἱ τε*, for the *ὅτι θ'* of Kühn's text. Helmreich omits the *οἱ λογισμοί* which follows immediately in Kühn's text. Hippocrates calls Nature just in his *De fracturis*, cap. 1 (Littré, III, 412-415).